(12) INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(19) World Intellectual Property Organization
International Bureau

(43) International Publication Date
11 December 2003 (11.12.2003)

PCT

(10) International Publication Number
WO 03/103171 A1

(51) International Patent Classification[7]: H04B 1/16, 1/06, 7/00

(21) International Application Number: PCT/US03/17369

(22) International Filing Date: 3 June 2003 (03.06.2003)

(25) Filing Language: English

(26) Publication Language: English

(30) Priority Data:
60/385,485 4 June 2002 (04.06.2002) US

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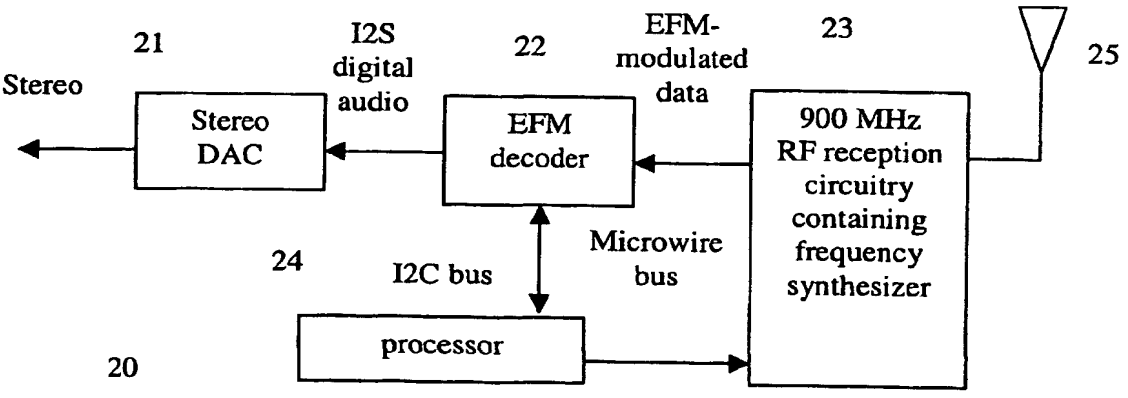
(81) Designated States *(national)*: AE, AG, AL, AM, AT, AU, AZ, BA, BB, BG, BR, BY, BZ, CA, CH, CN, CO, CR, CU, CZ, DE, DK, DM, DZ, EC, EE, ES, FI, GB, GD, GE, GH, GM, HR, HU, ID, IL, IN, IS, JP, KE, KG, KP, KR, KZ, LC, LK, LR, LS, LT, LU, LV, MA, MD, MG, MK, MN, MW, MX, MZ, NI, NO, NZ, OM, PH, PL, PT, RO, RU, SC, SD, SE, SG, SK, SL, TJ, TM, TN, TR, TT, TZ, UA, UG, US, UZ, VC, VN, YU, ZA, ZM, ZW.

(84) Designated States *(regional)*: ARIPO patent (GH, GM, KE, LS, MW, MZ, SD, SL, SZ, TZ, UG, ZM, ZW), Eurasian patent (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European patent (AT, BE, BG, CH, CY, CZ, DE, DK, EE, ES, FI, FR, GB, GR, HU, IE, IT, LU, MC, NL, PT, RO, SE, SI, SK, TR), OAPI patent (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, ML, MR, NE, SN, TD, TG).

Published:
— *with international search report*

For two-letter codes and other abbreviations, refer to the "Guidance Notes on Codes and Abbreviations" appearing at the beginning of each regular issue of the PCT Gazette.

(54) Title: WIRELESS SIGNAL LOSS DETECTION



(57) Abstract: An apparatus includes a receiver for receiving an audio file signal, a decoder (22) for demodulating the audio file signal; and a processor (24) for polling the decoder for a loss of a phase lock in the demodulating of the audio file signal. The processor resets and reinitializes the decoder in response to the loss in the phase lock loop. The receiver includes 900MHz radio frequency reception circuitry (23). The decoder comprises an eight-to-four modulation EFM decoder. In a preferred embodiment, the decoder outputs a digital audio stream that conforms to a known I2S audio stream format.

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WIRELESS SIGNAL LOSS DETECTION

FIELD OF THE INVENTION

The present invention relates generally to wireless communications, and more particularly to wireless signal loss detection.

DESCRIPTION OF THE RELATED ART

Many consumers want to enjoy a vast collection of digital audio files stored on their PC by playing those audio files on an audio system. Users have already been transferring audio files from CD storage onto their personal computers. Playing audio files directly from an Internet web site through a personal computer to a home audio system permits using the computer's processing and storage capacities to increase play lists, as well as organize a library of digital music files using ID3 tag song data to display artist, album, song title and genre. Wireless transmission and reception between a personal computer and the audio system would permit a higher quality listening experience for a user

Wireless transmitter and receiver techniques must be able to send CD-quality digital audio from the personal computer to the audio system. Active users of jukebox-managed personal computer content and Internet audio listeners seeking alternatives for listening to digital quality music files require a convenient connection between their personal computer and audio system. Continuous transmission and reception between the audio file source and the audio system is required for full user experience in listening to digital quality music files available from a personal computer or a network site.

Wireless transmission techniques applied to audio files transmitted to a wireless receiver can cease its decoding after long periods of transmission idleness from the audio file transmitter source. A phase lock loop in the decoding by the receiver can unlock. Loss of the phase lock loop by the receiver would require the user to manually re-establish a phase lock loop in the decoding of audio file transmissions from the transmitter. Accordingly there is a need for detecting signal loss between the receiver and the signal transmitter and

automatically resetting a signal phase lock to maintain near seamless playing of audio files received over a wireless communications link.

SUMMARY OF THE INVENTION

The present apparatus includes a receiver for receiving an audio file signal, a decoder for demodulating the audio file signal, and a processor for polling the decoder for a loss of a phase lock in the demodulating of the audio file signal. The processor resets and reinitializes the decoder in response to the loss in the phase lock loop. The receiver includes 900 MHz radio frequency reception circuitry. The decoder comprises an eight-to-fourteen modulation EFM decoder. In a preferred embodiment, the decoder outputs a digital audio stream that conforms to a known I2S audio stream format.

The present computer readable medium contains software instructions that, when executed by a processor, perform the steps of receiving a modulated audio file signal, demodulating the modulated audio file signal, polling the demodulating for a loss in a phase lock in the demodulating, and resetting and reinitializing the demodulating in reply to the loss in the phase lock. The demodulating is preferably a demodulation of an eight-to-fourteen EFM bit digital encoding synchronized to a 900 MHz range carrier frequency modulated by the digital encoding

A method for detecting a signal loss in a wireless audio file signal transmission includes the steps of receiving an audio file signal, decoding the audio file signal, and polling the decoder for a loss of a phase lock in the decoding of the audio file signal. In response to the loss in the phase lock in the decoding the decoder is reset and reinitialized. The step of receiving, preferably, is synchronized to a 900 MHz range carrier frequency modulated by the audio file signal. The step of decoding includes an eight-to-fourteen bit modulation EFM decoding.

BRIEF DESCRIPTION OF THE DRAWINGS

A more complete understanding of the present invention may be obtained from consideration of the following description in conjunction with the drawings, in which:

FIG. 1 depicts an exemplary communications environment including an Internet network, a computer, a wireless transmitter, a wireless receiver, and an audio system.

FIG. 2 is a block diagram of an exemplary wireless receiver for implementing the invention; and

FIG. 3 depicts a wireless phase locked loop unlocked condition and recovery flow chart suitable for use in the receiver of FIG. 2;

To facilitate understanding, identical reference numerals have been used, where possible, to designate identical elements that are common to the figures.

DETAILED DESCRIPTION

FIG. 1 depicts an exemplary communications environment 10 including an exemplary network 12, such as the Internet, a personal computer 11 with wireless transmitter 13, and a wireless receiver 14. The wireless transmitter 13 transfers audio files on the computer 11 to the wireless receiver 14 over wireless medium 15. The wireless receiver then sends the analog stereo signal to the audio system 16. The audio files can be any one of various file types, such as mp3, files stored for retention during shutoff of the computer or stored temporarily when the computer serves as a conduit for transmission of audio files from across the network to the wireless receiver 14. The transmitter 13 can be an integral component of the computer's architecture or an add-on device communicating with the computer through a port connection, such as a universal serial bus connection USB. The exemplary computer 11, shown as a laptop computer, can be a desktop computer system or a processor based device capable of relaying transfer of audio files from across a network to the wireless receiver 14.

FIG. 2 is a block diagram of an exemplary wireless receiver. An incoming modulated or encoded analog signal received at an antenna 25 is received into the reception circuitry board 23 containing a frequency synthesizer for synchronizing the receiver to an exemplary

transmitter carrier frequency in the range of 900 MHz. The encoded signal is decoded by an eight-to-fourteen modulation decoder 22. Eight-to-fourteen EFM encoding is a known encoding technique for compact disk CD encoding. A digital audio stream I2S from the decoder 22 is changed by the stereo digital-to-analog converter DAC 21 into an analog stereo input signal to an audio system. Communications protocols between the decoder 22 and processor 24 preferably conform to known I2C bus protocols. The processor is preferably a microprocessor tied over a microwire bus to the reception circuitry 23. The processor controls the frequency synthesizer for synchronizing the receiver to the radio carrier frequency of the audio file signal source transmitter. The processor 24 also carries out the inventive wireless audio file signal loss detection and resetting and initialization of the decoder 22 when a loss of the wireless audio file signal is detected.

FIG. 3 is a flow chart for detecting a wireless phase lock loop PLL unlocked condition and recovery flow chart for use in the receiver of FIG. 2. The processor 24 continually polls the decoder 32 to determine if a phase lock loop in the demodulation of the incoming audio file signal has been lost 33. If the decoder's phase lock loop PLL has unlocked the processor undertakes a software reset of the decoder and reinitializes a phase lock loop condition in the decoding of the audio file signal received at the antenna 25. If the decoder's phase lock loop PLL remains locked, the processor 24 continues to poll the decoder for an unlocked condition in the phase lock loop. The automatic EFM PLL unlocked condition detection and recovery allows for no user awareness or intervention requirement.

Although various embodiments which incorporate the teachings of the present invention have been shown and described in detail herein, those skilled in the art can readily devise many other varied embodiments that will still incorporate these teachings. The present invention has been described within the context of an audio system receiving transmission of audio files from a personal computer. It will be appreciated by those skilled in the art that the teachings of the present invention directed to wireless signal loss detection recovery may be practiced where the wireless signal is transmitting audio files stored on the computer or audio files downloaded from across the network onto the computer for streaming transfer to the audio system. The audio system can be equipped with an analog stereo input jack, e.g. a home stereo with a "LINE" or "AUX" jack, for receiving the stereo audio signal.

Claims:

1. Apparatus comprising:

a receiver (23) for receiving an audio file signal;

a decoder (22) for demodulating said audio file signal; and

a processor (24) for polling said decoder for a loss of a phase lock in said demodulating of said audio file signal.

2. The apparatus of claim 1, wherein said processor resets and reinitializes said decoder in response to said loss in said phase lock.

3. The apparatus of claim 1, wherein said receiver comprises 900 MHz radio frequency reception circuitry.

4. The apparatus of claim 1, wherein said decoder comprises an eight-to-four modulation EFM decoder.

5. The apparatus of claim 1, wherein said decoder outputs a digital audio stream.

6. The apparatus of claim 5, wherein said digital audio stream conforms to an I2S audio stream.

7. A computer readable medium containing software instructions that, when executed by a processor, perform the steps of:

receiving a modulated audio file signal;

demodulating said modulated audio file signal;

polling said demodulating for a loss in a phase lock in said demodulating; and

resetting and reinitializing said demodulating in reply to said loss in said phase lock.

8. The computer readable medium according to claim 7, wherein said demodulating is a digital eight-to-fourteen modulation digital decoding.

9. The computer readable medium according to claim 7, wherein said receiving is synchronized to a 900 MHz range carrier frequency modulated by said audio file signal.

10. The computer readable medium according to claim 7, wherein said demodulating outputs a digital audio stream.

11. The computer readable medium according to claim 7, wherein said polling is carried out by a processor.

12. A method for detecting a signal loss in a wireless audio file signal transmission, said method comprising the steps of:

receiving an audio file signal;

decoding said audio file signal; and

polling (32) said decoding for a loss of a phase lock in said decoding of said audio file signal..

13. The method of claim 12, further comprising the step of resetting and reinitializing (31) said decoding in response to said loss in said phase lock in said decoding.

14. The method of claim 12, wherein said step of receiving comprises 900 MHz range carrier frequency synchronizing.

15. The method of claim 12, wherein said step of decoding comprises an eight-to-fourteen bit modulation EFM decoding.

16. The method of claim 12, wherein said step of decoding outputs a digital audio stream.

17. The method of claim 16, wherein said digital audio stream conforms to an I2S audio stream.

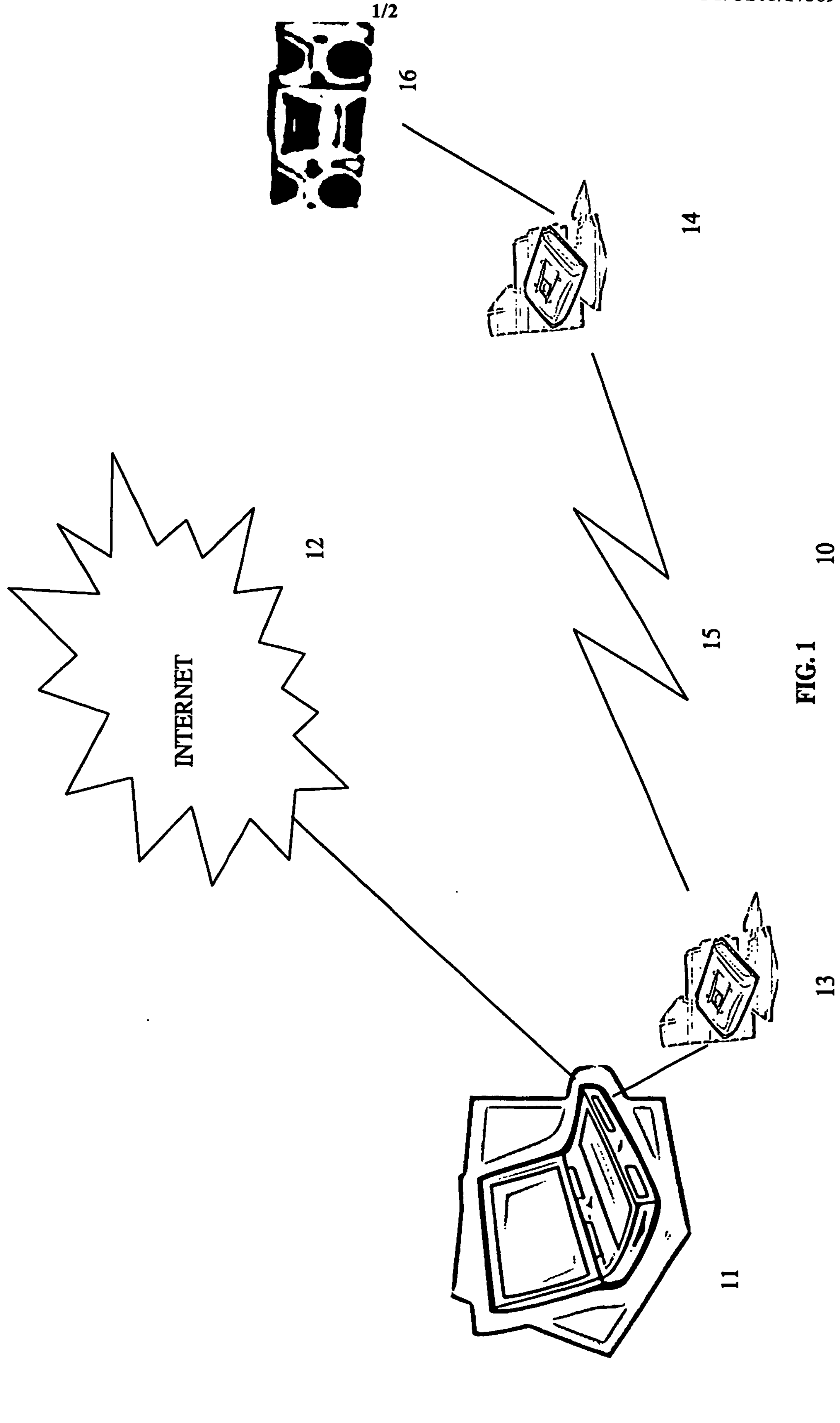

FIG.1

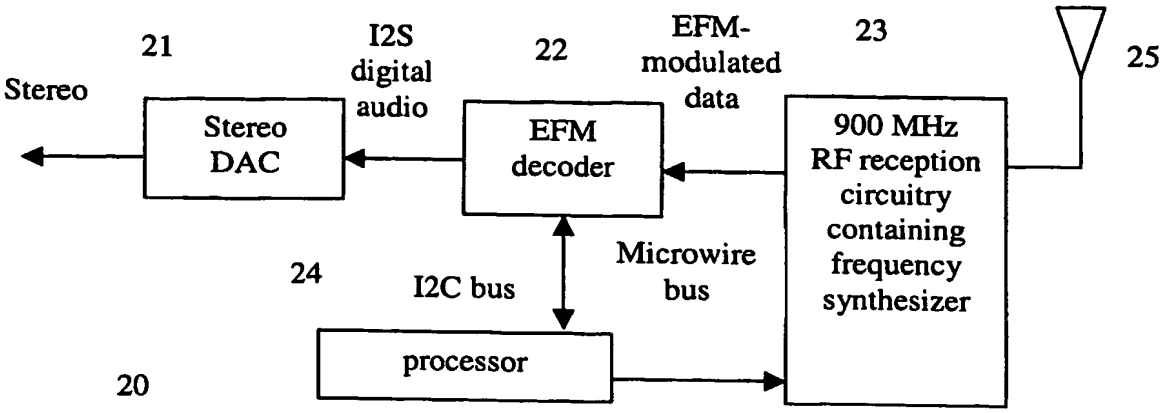
21
I2S digital audio
22
EFM-modulated data
23
25
Stereo
Stereo DAC
EFM decoder
900 MHz RF reception circuitry containing frequency synthesizer
24
I2C bus
Microwire bus
processor
20

FIG. 2

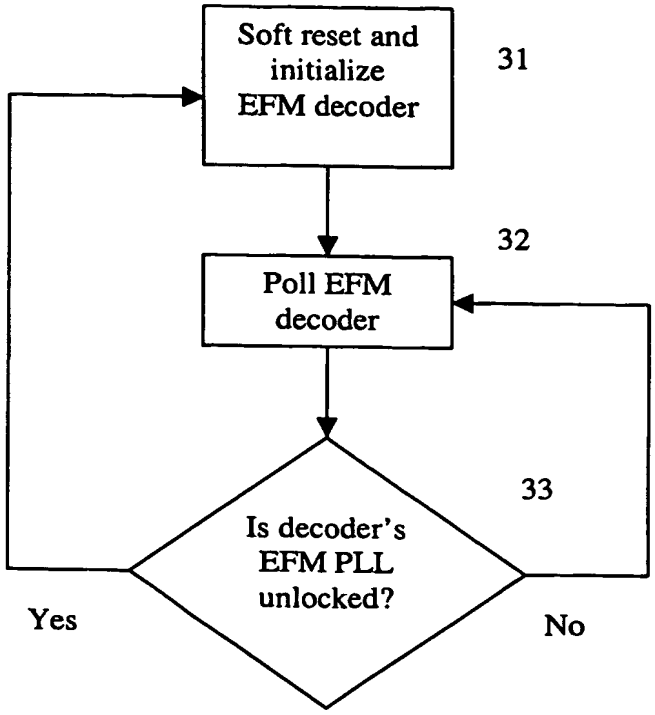
Soft reset and initialize EFM decoder
31
32
Poll EFM decoder
33
Is decoder's EFM PLL unlocked?
Yes
No

FIG. 3

30

INTERNATIONAL SEARCH REPORT

International application No.
PCT/US03/17369

A. CLASSIFICATION OF SUBJECT MATTER

IPC(7) : H04B 1/16, 1/06, 7/00
US CL : 455/131, 136, 151.2, 164.1, 205, 240.1, 260, 295, 296, 3.03, 3.06,

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
U.S. : 455/131, 136, 151.2, 164.1, 205, 240.1, 260, 295, 296, 3.03, 3.06,

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y,P	US 2002/0085713 A1 (FEIG et al) 04 July 2002, see paragrpahs 5-10	1-17
A,P	US 6,496,692 B1 (SHANAHAN) 17 December 2002, see col. 5, lines 10-65.	1-17
Y	US 5,950,115 A (MOMTAZ et al) 07 September 1999, see abstract, col 15, line 11- col. 16, line 39.	1-17
A	US 6,182,128 B1 (KELKAR et al) 30 January 2001, see col. 7, lines 22-46	1, 7 and 12

☐ Further documents are listed in the continuation of Box C. ☐ See patent family annex.

* Special categories of cited documents:

"A" document defining the general state of the art which is not considered to be of particular relevance

"E" earlier application or patent published on or after the international filing date

"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art

"&" document member of the same patent family

Date of the actual completion of the international search
08 August 2003 (08.08.2003)

Date of mailing of the international search report
23 SEP 2003

Name and mailing address of the ISA/US
Mail Stop PCT, Attn: ISA/US
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Form PCT/ISA/210 (second sheet) (July 1998)

PATENT COOPERATION TREATY

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INTERNATIONAL PRELIMINARY EXAMINATION REPORT

(PCT Article 36 and Rule 70)

Applicant's or agent's file reference PU020269	**FOR FURTHER ACTION**	See Notification of Transmittal of International Preliminary Examination Report (Form PCT/IPEA/416)
International application No. PCT/US03/17369	International filing date *(day/month/year)* 03 June 2003 (03.06.2003)	Priority date *(day/month/year)* 04 June 2002 (04.06.2002)
International Patent Classification (IPC) or national classification and IPC IPC(7): H04B 1/16, 1/06, 7/00 and US Cl.: 455/131, 136, 151.2, 164.1, 205, 240.1, 260, 295, 296, 3.03, 3.06,		
Applicant THOMSON LICENSING S.A.		

1. This international preliminary examination report has been prepared by this International Preliminary Examining Authority and is transmitted to the applicant according to Article 36.

2. This REPORT consists of a total of 5 sheets, including this cover sheet.

   ☐ This report is also accompanied by ANNEXES, i.e., sheets of the description, claims and/or drawings which have been amended and are the basis for this report and/or sheets containing rectifications made before this Authority (see Rule 70.16 and Section 607 of the Administrative Instructions under the PCT).

   These annexes consist of a total of ___ sheets.

3. This report contains indications relating to the following items:

   - I ☒ Basis of the report
   - II ☐ Priority
   - III ☐ Non-establishment of report with regard to novelty, inventive step and industrial applicability
   - IV ☐ Lack of unity of invention
   - V ☒ Reasoned statement under Article 35(2) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement
   - VI ☐ Certain documents cited
   - VII ☐ Certain defects in the international application
   - VIII ☐ Certain observations on the international application

Date of submission of the demand	Date of completion of this report
30 December 2003 (30.12.2003)	20 July 2004 (20.07.2004)
Name and mailing address of the IPEA/US Mail Stop PCT, Attn: IPEA/US Commissioner for Patents P.O. Box 1450 Alexandria, Virginia 22313-1450 Facsimile No. (703) 305-3230	Authorized officer Edan Orgad Telephone No. 703-305-4223

INTERNATIONAL PRELIMINARY EXAMINATION REPORT

International application No.
PCT/US03/17369

I. Basis of the report

1. With regard to the **elements** of the international application:*

☒ the international application as originally filed.

☒ the description:
pages 1-4 as originally filed
pages NONE , filed with the demand
pages NONE , filed with the letter of _____.

☒ the claims:
pages 5 and 6 , as originally filed
pages NONE , as amended (together with any statement) under Article 19
pages NONE , filed with the demand
pages NONE , filed with the letter of _____.

☒ the drawings:
pages 1-2 , as originally filed
pages NONE , filed with the demand
pages NONE , filed with the letter of _____.

☐ the sequence listing part of the description:
pages NONE , as originally filed
pages NONE , filed with the demand
pages NONE , filed with the letter of _____.

2. With regard to the **language**, all the elements marked above were available or furnished to this Authority in the language in which the international application was filed, unless otherwise indicated under this item.
These elements were available or furnished to this Authority in the following language _____ which is:

☐ the language of a translation furnished for the purposes of international search (under Rule23.1(b)).

☐ the language of publication of the international application (under Rule 48.3(b)).

☐ the language of the translation furnished for the purposes of international preliminary examination(under Rules 55.2 and/or 55.3).

3. With regard to any **nucleotide and/or amino acid sequence** disclosed in the international application, the international preliminary examination was carried out on the basis of the sequence listing:

☐ contained in the international application in printed form.

☐ filed together with the international application in computer readable form.

☐ furnished subsequently to this Authority in written form.

☐ furnished subsequently to this Authority in computer readable form.

☐ The statement that the subsequently furnished written sequence listing does not go beyond the disclosure in the international application as filed has been furnished.

☐ The statement that the information recorded in computer readable form is identical to the written sequence listing has been furnished.

4. ☐ The amendments have resulted in the cancellation of:

☐ the description, pages NONE

☐ the claims, Nos. NONE

☐ the drawings, sheets/fig NONE

5. ☐ This report has been established as if (some of) the amendments had not been made, since they have been considered to go beyond the disclosure as filed, as indicated in the Supplemental Box (Rule 70.2(c)).**

** Replacement sheets which have been furnished to the receiving Office in response to an invitation under Article 14 are referred to in this report as "originally filed" and are not annexed to this report since they do not contain amendments (Rules 70.16 and 70.17).*
*** Any replacement sheet containing such amendments must be referred to under item 1 and annexed to this report.*

INTERNATIONAL PRELIMINARY EXAMINATION REPORT

International application No.
PCT/US03/17369

V. Reasoned statement under Rule 66.2(a)(ii) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement

1. STATEMENT

Novelty (N)	Claims	1-17	YES
	Claims	NONE	NO
Inventive Step (IS)	Claims	2, 7-11 and 13	YES
	Claims	1, 3-6, 12 and 14-17	NO
Industrial Applicability (IA)	Claims	1-17	YES
	Claims	NONE	NO

2. CITATIONS AND EXPLANATIONS
Please See Continuation Sheet

Supplemental Box
(To be used when the space in any of the preceding boxes is not sufficient)

V. 2. Citations and Explanations:
Claim 1, 3-6, 12 and 14-17 lack an inventive step under PCT Article 33(3) as being obvious over Hunsinger et al (US 5,850,415) in view of Cashen et al (US 5,878,336).

Regarding claims 1 and 12, Hunsinger teaches a receiver for receiving an audio file signal (abstract) a decoder for demodulating said audio file signal (fig. 16, element 286). However, Hunsinger fails to teach a processor for polling said decoder for a loss of a phase lock in said demodulating of said audio file signal. However, in the same field of endeavor, Cashen teaches a processor for polling said decoder for a loss of a phase lock in said demodulating of said audio file signal (col. 3, lines 11-37). Therefore, it would have been obvious to combine Cashen's teachings of a processor for polling said decoder for a loss of a phase lock in said demodulating of said audio file signal with Hunsinger's digital broadcasting system in order to discontinuously operate the receiver in a communication that requires reception and evaluation of data field in their entirety.

Regarding claims 3 and 14, Hunsinger fails to specifically disclose said receiver comprises a 900MHz radio frequency reception circuitry. However, official notice is taken that a receiver comprises a 900MHz radio frequency reception circuitry is very well known. Therefore, it would have been obvious to use a receiver comprising a 900MHz radio frequency reception circuitry with Hunsinger in order to provide the user with a broader range of frequencies.

Regarding claims 4 and 15, Hunsinger fails to specifically disclose said decoder comprises an eight to four modulation EFM decoder. However, official notice is taken that an eight to four modulation EFM decoder is well known in the art. Therefore, it would have been obvious to use an eight to four modulation EFM decoder with Hunsinger's receiver in order to translate the original data into its original format.

Regarding claims 5, 6, 16 and 17, Hunsinger teaches said decoder outputs a digital audio stream (see abstract) but fails to disclose that it conforms to an IS2 audio stream. However, official notice is taken that IS2 audio streams are well known. Therefore, it would have been obvious to use IS2 audio stream with Hunsinger's existing audio stream in order to have 16 bits represent left channel audio samples, and the other 16 bits represent right channel audio Samples.

Claims 2,7-11 and 13 meet the criteria set out in PCT Article 33(2)-(3), because the prior art does not teach or fairly suggest:

Regarding claims 2 and 13, the prior art of record fails to specifically disclose said processor resets and reinitializes said decoder in response to said loss in said phase lock.

Regarding claim 7-11, Regarding claim 7, the prior art of record teaches a receiver for receiving an audio file signal (abstract) a decoder for demodulating said audio file signal, a processor for polling said decoder for a loss of a phase lock in said demodulating of

Supplemental Box
(To be used when the space in any of the preceding boxes is not sufficient)

said audio file signal (fig. 16, element 286). However, the prior art of record fails to specifically disclose said processor resets and reinitializes said decoder in response to said loss in said phase lock.

---------- NEW CITATIONS ----------

US 5,748,046 A (Badger) 5 May 1998, see entire document.
US 5,878,336 A (Cashen et al) 2 March 1999, see entire document.
US 5,850,415 A (Hunsinger et al) 15 December 1998, see entire document.